Remarks

Claims 1-28 are the subject of the current office action. It is noted that the Examiner states that claims 27-53 were withdrawn and that the applicant's election of claims 1-26 is acknowledged. This is believed to be a typographical error; claims 1-28 were elected, and claims 1-27 appear to be the subject of the current office action. New claims 54 and 55 are added. Thus, claims 1-28, 54, and 55 are hereby presented for further consideration.

Claims 1-27 stand rejected under 35 USC §112, first paragraph, as lacking enablement. The applicants respectfully traverse this rejection. The specification as provided discloses many embodiments of the subject invention that teach the skilled artisan how to make and use the claimed invention. For example, paragraphs 7, 56, 57 and 89 all teach various uses of the claimed invention. Also, the examples of the specification teach the skilled artisan how to synthesize faceted polymeric molecules or structures of the claimed invention. Furthermore, claims 54 and 55 present two specific polyhedron molecules in accordance with the claimed invention.

The applicants have submitted herewith a declaration, including exhibits, under 37 CFR §1.132, establishing that the subject invention is enabling for the full scope of the claimed invention. The ordinary skilled artisan would understand that faceted polyhedra applies to a multitude of molecular polygons and linking moieties, all of which are readily available to the ordinary artisan and can be assembled into the faceted polyhedra that is taught in the subject application.

The application provides attributes that give adequate direction in how to choose appropriate molecular polygons and linking moieties depending on, for example, the type of geometric shape desired or whether the polygon molecule should contain a metal. As taught in the application, the components of the molecular polygons are those capable of sustaining the desired rotational symmetry. Although an illustrative list of these types of metals and non-metals are given, one skilled in the art would understand that any type of metal or nonmetal could be used as long as the rotational symmetry requirement is met. Additionally, the application teaches that the linking molecules are selected to sustain a desired dihedron angle between the molecular polygons as well as proving illustrative lists. Thus, the skilled artisan is not limited to merely making and using just the faceted polyhedra specified in the examples. In

fact, as more fully explained below, a number of those skilled in the art have successfully followed the teachings of the inventors to produce non-exemplified faceted polyhedra, thereby proving the broadly-enabled character of our teachings.

Geometry teaches those skilled in the art that *faceted polyhedra* can only be generated from certain polygons or combinations of polygons. The examples and the following publications demonstrate that molecular squares that are linked at a 120 degree angle self-assemble (*i.e.* a spontaneous one-pot chemical process) to form one of the nine possible faceted polyhedra: the small rhombihexahedron. To the applicants' knowledge this represents the first example of such a chemical structure. The application and the papers demonstrate that a series of metal-organic moieties that approximate the shape of squares can be linked by angular "spacers" (iso-phthallic acid and several of its derivatives) to generate a molecular scale version of the small rhombihexahedron. Given the teachings of the subject application, one of ordinary skill in the art would readily envision how other molecular squares, triangles or pentagons (three three polygons that can sustain faceted polyhedra) linked by other angular "spacers" could be used to generate the full series of faceted polyhedra. In particular, the following support both the generality and potential importance of this class of compounds:

- This class of compounds will be based upon previously reported molecular species and will thereby be facile and typically inexpensive to synthesize.
- The structures of the claimed invention can be afforded via self-assembly meaning that they can be prepared in one-step with high yield.
- The nature of self-assembly is that products are inherently modular since they contain at least two components, affording diversity of compositions since both the polygon and the spacer can be modified without loss of overall topology.
- Many of the compounds described herein are stable to 200°C, and others are stable at or above 400°C.
- Modular compounds can be designed so as to contain at least two chemically active components. For example, a metal complex or organic molecule could be chosen for luminescence or molecular recognition properties as well as its structural features, and metal complexes could be selected for magnetic[103] or catalytic properties.
- Components could be neutral or ionic and the faceted polyhedra could, therefore, also be designed to be ionic or neutral.

Several articles authored in part by the co-inventors provide further evidence that the application is enabling for the full extent of the claims. The list of publications includes:

B1. B. Moulton & Zaworotko, M. "From Molecules to Crystal Engineering: Supramolecular Isomerism and Polymorphism in Network Solids." *Chem Rev.* 2001, 101, 1629-58.

B2. B. Moulton; Lu, J.; Mondal, A.; & Zaworotko, M. "Nanoballs: nanoscale faceted polyhedra with large windows and cavities." *Chem. Commun.*, 2001, 863-64.

B3. B. Moulton; Lu, J.; Hajndl, R.; Hariharan, S.; & Zaworotko, M. "Crystal Engineering of a Nanoscale Kagomé Lattice." *Angew. Chem. Int. Ed.* 2002, 41, No. 15.

B4. Abourahma, H.; Coleman, A.; Moulton, B.; Rather, B.; Shahgaldian, P.; & Zaworotko, M. "Hydroxylated nanoballs: synthesis, crystal structure, solubility and crystallization on surfaces." *Chem. Commun.*, 2001, 2380-2381.

B5. Bourne, S.; Lu, J.; Mondal, A.; Moulton, B.; & Zaworotko, M. "Self-Assembly of Nanometer-Scale Secondary Building Units into an Undulating Two-Dimensional Network with Two Types of Hydrophobic Cavity." *Angew Chem. Int. Ed.* 2001, 40, 2111-13.

B6. McManus, G. J.; Wang, Z.; Zaworotko, M. "Suprasupermolecular Chemistry: Infinite Networks from Nanoscale Metal-Organic Building Blocks", *Crystal Growth & Design*, 4, 11-13, 2004.

The above-referenced articles, full copies of which are attached as Exhibit B, contain much of the same teachings as the subject application, have been highly cited since their publication, and thereby have taught others possessing ordinary skills in the art to make and use the claimed invention. In particular, B1 was named the "hot paper for chemistry" by the Institute for Scientific Information in June 2003 since it had been cited 244 times within two years of publication, the most of any chemistry article published in this time period (June 2001-June 2003). As of August 2004, this article has been cited 570 times. Some of these articles have also been featured in other esteemed scientific journals. B2 is an Editor's Choice in the May 18, 2001 issue of *Science*, and B3 was highlighted in the News and Views section of *Nature Materials* in their October 2002 issue.

Not only did B2 and B3 gain additional publicity in the above journals, these articles have been used and cited in over 25 articles each. A full text copy of one such article (C1) is attached in Exhibit C.

Thus, in view of these publications in the field showing success in following our teachings, the disclosure of the subject invention enables another skilled in the art to make and use the claimed invention. Accordingly, the applicants respectfully request reconsideration and withdrawal of the rejection under 35 USC §112, first paragraph.

Claims 1-27 stand rejected under 35 USC §112, second paragraph, as being indefinite. The applicants respectfully traverse this rejection and submit herewith a 37 CFR 1.132 declaration to refute the rejection. The applicants submit that the claims reasonably define the patentable subject matter.

However, the terminology of the claims is consistent with the terminology used by one ordinarily skilled in the art. The term "faceted uniform polyhedra" is defined in the specification of the subject application as "[t]he resulting nine closed sets of polygons that are sustained by vertex-linked triangles, squares, pentagons, or combinations thereof, ..." (Paragraph 84). This term has consistently been used in publications since 2001.

Furthermore, the other elements of the faceted polyhedra are defined in the specification or known to someone skilled in the art. For example, the term "polygon moiety" is defined in the application as a "polygon-shaped moiet[y] which contribute[s] to the polyhedron molecules and polymeric structures of the subject invention" (Paragraph 92). Someone of ordinary skill in the art understands that the moieties' arrangement of atoms approximate geometric structures.

Likewise, the term "linking moiety" is known in the chemical arts. Additionally, the application specifically defines what is meant by linking moieties in the context of the claimed invention in paragraphs 95-97.

Thus, the claimed invention does define the bounds of the claimed invention using terms well known within the art and defined in the subject application. Accordingly, the applicants respectfully request reconsideration and withdrawal of the rejection under 35 USC §112, second paragraph.

Claims 1-4 and 19-21 stand rejected under 35 USC §102(a) as being anticipated by Stowell *et al.* The applicants respectfully point out that the subject application claims priority to

provisional patent Application Serial No. 60/270,998, which has a filing date of February 23, 2001, and provisional patent application Serial No. 60/314,855, which has a filing date of August 24, 2001. In contrast, the Stowell *et al.* reference was published on the internet on September 27, 2001. Accordingly, the applicants submit that Stowell *et al.* is not available as prior art with respect to the subject invention, and reconsideration and withdrawal of the rejection under 35 USC §102(a) is respectfully requested.

Claims 1-4, 12-23, 26 and 27 stand rejected under 35 USC §102(e) as being anticipated by Spencer *et al.* The applicants respectfully traverse this rejection because the cited reference does not disclose each and every element of the claimed invention. Specifically, Spencer *et al.* fails to teach a faceted polyhedra molecule wherein the molecule has open and closed convex faces. Advantageously, linking polyhedron molecules at their vertices produces an open polymeric structure with great porosity. The combination of open and closed faces in a single polyhedra is synthesized when polygon moieties are connected at their vertices with a linker. As defined in the specification, polygon moieties are those moieties with external chemical functionalities that are arranged in such a way that the functionalities lie at the vertices of the polygon.

In contrast, the cluster frameworks, for example, borane and carboborane, taught in Spencer *et al.* are polygons connected at their edges. Thus, the cluster frameworks of the Spencer nanosystems are closed polyhedra. Accordingly, the Spencer *et al.* reference does not disclose each and every element of the claimed invention, and the applicants respectfully request reconsideration and withdrawal of the rejection under 35 USC §102(e).

Claims 1, 13, 16, and 26 stand rejected under 35 USC §102(e) as being anticipated by Seeman *et al.* The applicants respectfully traverse this rejection because Seeman *et al.* does not disclose each and every element of the claimed invention. Seeman *et al.* discloses two and three dimensional polynuceic acid structures. The Seeman reference's structures are constructed of ordered arrays of antiparallel double crossover molecules.

The vertices of the Seeman lattices are bulges from the nucleic acids rather than individual polygon moieties. In contrast, the polygon moieties of the claimed invention are polygon moieties with vertices having external chemical functionalities that are arranged in such

a way that the functionalities lie at the vertices of the polygon. The polygon moieties are bonded at their vertices with a linking moiety.

Furthermore, the nanoconstructions disclosed in Seeman *et al.* do not teach faceted polyhedra molecules or structures. As noted above, faceted polyhedra molecules are defined in paragraph 84 as a set of polygons connected at their vertices and having both open and closed faces. In contrast, the nanostructures of Seeman as seen in Figures 11A, 11B, and 13 contain closed faces. Furthermore, these structures are connected at their edges. Thus, Seeman *et al.* fails to teach polygon moieties connected at their vertices by a linking moiety. Accordingly, Seeman does not disclose each and every element of the claimed invention, and the applicants respectfully request reconsideration and withdrawal of the § 102(e) rejection.

The applicants believe that this application is in condition for allowance, and such action is earnestly solicited.

The Assistant Commissioner is hereby authorized to charge any fees under 37 CFR §§1.16 and 1.17 as required by this paper to Deposit Account 19-0065.

The applicants invite the Examiner to call the undersigned if clarification is needed on any of this response, or if the Examiner believes a telephonic interview would expedite the prosecution of the subject application to completion.

Respectfully submitted,

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JMM/ehm

Attachments: 37 CFR §1.132 Declaration
Exhibit A: Dr. M.J. Zaworotko's Curriculum Vitae
Exhibit B: References B1-B6
Exhibit C: Reference C1
Petition and Fee for One-Month Extension of Time